Lloyd's Register

Rules and Regulations for the Classification of Special Service Craft, July 2010

Notice No. 5

Effective Date of Latest Amendments:

See page 1

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RULES AND REGULATIONS FOR THE CLASSIFICATION OF SPECIAL SERVICE CRAFT, *July 2010*

Notice No. 5

This Notice contains amendments within the following Sections of the *Rules and Regulations for the Classification of Special Service Craft, July 2010.* The amendments are effective on the dates shown:

Part	***Chapter***	***Section***	***Effective date***
3	5	8	1 July 2011
9	1	1, 3	1 July 2011
10	1	14	1 July 2011
12	2	1, 2 ,3 ,4, 5, 6, 7, 8	1 July 2011
14	1	6, 7	1 July 2011
15	1	1,9	1 July 2011
15	2	11, 15	1 July 2011
15	3	4, 6	1 July 2011
16	1	1, 2, 6	1 July 2011
16	2	2, 5, 10, 11, 18, 20	1 July 2011

It will be noted that the amendments also include corrigenda, which are effective from the date of this Notice.

The *Rules and Regulations for the Classification of Special Service Craft, July 2010* are to be read in conjunction with this Notice No. 5. The status of the Rules is now:

Rules for Special Service Craft	Effective date:	July 2010
Notice No. 1	Effective date:	1 January 2011
Notice No. 2	Effective date:	1 January 2011
Notice No. 3	Effective date	1 February 2011
Notice No. 4	Effective date	1 July 2011
Notice No. 5	Effective date	1 July 2011

Part 3, Chapter 5
Anchoring and Mooring Equipment

Effective date 1 July 2011

■ *Section 8*
Windlass design and testing

8.2 ~~Performance~~ Windlass design

(Part only shown)

8.2.1 The following performance criteria are to be used as a design basis for the windlass:

(a) The windlass is to have sufficient power to exert a continuous duty pull of:
~~28,00d_c^2 N~~ 28,5 d_c^2 N – for Grade U1 chain, with $d_c < 14$ mm
~~36,79d_c^2 N~~ 37,5 d_c^2 N – for Grade U1 chain, with $d_c \geq 14$ mm
~~41,68d_c^2 N~~ 42,5 d_c^2 N – for Grade U2 chain
~~46,60d_c^2 N~~ 47,5 d_c^2 N – for Grade U3 chain
over a period of 0,12L_c minutes. The test period need not be taken longer than 30 minutes

where
d_c is the chain diameter, in mm
L_c is the total length of chain cable on board, in metres, as given by Table 5.6.1.

8.2.3 Calculations for torque transmitting components are to be based on 1500 hours of operation with a nominal load spectrum factor of 1,0. Alternatively, unlimited hours with a nominal load spectrum factor of 0,8 can be applied.

8.2.4 Where the available input torque exceeds the torque required for anchor breakout, torque overload protection is to be fitted.

8.2.5 An arrangement to release the anchor and chain in the event of windlass power failure is to be provided.

8.2.6 The maximum calculated stress from the load cases stated in Table 5.8.1 are not to exceed the permissible stress limits stated in Table 5.8.2.

8.2.7 The following criteria are to be used for gearing design:

(a) Torque is to be based on the performance criteria specified in 8.2.1.
(b) The use of an equivalent torque, T_{eq}, for dynamic strength calculations is acceptable but the derivation is to be submitted to LR for consideration.
(c) The application factor for dynamic strength calculation, K_A, is to be 1,15.
(d) Calculations are to be based on 1500 hours of operation.
(e) The static torque is to be 1,5 x T_n, where T_n is the nominal torque.
(f) The minimum factors of safety for load capacity of spur and helical gears, as derived using ISO 6336 or a relevant National or International Standard acceptable to LR, are to be 1,5 for bending stress and 0,6 for contact stress.

8.2.8 Keyways are to be designed to a relevant National or International Standard acceptable to LR.

8.2.9 The maximum stress in brake components is not to exceed the permissible stress stated in Table 5.8.2.

Existing 8.2.3 *and* 8.2.4 *have been renumbered to* 8.2.10 *and* 8.2.11.

8.3 Control arrangements

8.3.1 All control devices are to be capable of being controlled from readily accessible positions and protected against unintentional operation.

8.3.2 The maximum travel of the levers is not to exceed 600 mm if movable in one direction only, or 300 mm to either side from a central position if movable in both directions.

8.3.3 Wherever practical, the lever is to move in the direction of the intended movement. If this cannot be achieved, then it is to move towards the right when hauling and towards the left when paying out.

8.3.4 For lever-operated brakes, the brake is to engage when the lever is pulled and disengage when the lever is pushed. The physical effort on the brake for the operator is not to exceed 160 N.

8.3.5 For pedal-operated brakes, the maximum travel is not to exceed 250 mm and the physical effort for the operator is not to exceed 320 N.

8.3.6 The handwheel or crankhandle is to actuate the brake when turned clockwise and release it when turned counterclockwise. The physical effort for the operator is not to exceed 250 N for speed regulation and 500 N at any moment.

8.3.7 When not provided with automatic sequential control, separate push-buttons are to be provided for each direction of operation.

8.3.8 The push-buttons are to actuate the machinery when depressed, and stop and effectively brake the machinery when released.

8.3.9 The above-mentioned individual push-buttons may be replaced by two ‘start’ and ‘stop’ push-buttons.

8.3.10 Control systems, whether electric, pneumatic or hydraulic, are to comply with the general requirements of Pt 6, Ch 1,2.

8.4 Maintenance arrangements

8.4.1 Access is to be provided for inspection of reduction gears, bearings, brakes, etc.

8.4.2 Accessible manual lubrication points, including nipples, are to be provided for both oil and grease, as applicable.

8.4.3 Gear-boxes are to be provided with adequate access arrangements for monitoring and replacing oil.

8.5 Protection arrangements

8.5.1 Where applicable, moving parts of windlass machinery are to be provided with suitable railings and/or guards to prevent injury to personnel.

8.5.2 Protection is to be provided for preventing persons from coming into contact with surfaces having temperatures over 50°C.

8.5.3 Steel surfaces not protected by lubricant are to be protected by a coating in accordance with the requirements of a relevant National or International Standard acceptable to LR.

8.5.4 For arrangements of power transmission systems and relief requirements, *see* Pt 5, Ch 14,9.1.

8.6 Marking and identification

8.6.1 Controls are to be permanently marked for identification, unless their functions are readily apparent. If required, instructions are to be permanently marked and readily visible.

Existing sub-Section 8.3 *has been renumbered* 8.7.

Existing sub-Section 8.4 *has been renumbered* 8.8.

Table 5.8.1 Design load cases for windlass and chainstopper

Load case	Condition	Note
1 2 3	Continuous pull Overload pull Brake holding load	*See* 8.2.1 (a) *See* 8.2.1 (b) *See* 8.2.1 (c)

Table 5.8.2 Permissible stress for design load cases

Stress	Load case	
	1 and 2 7	3
	Permissible stress	
Tension	0,8 *Y*	0,9*Y*
Compression or bending	0,8 *Y*	0,9*Y*
Shear	0,7 *Y*	0,7*Y*
Combined	0,85 *Y*	0,9*Y*

NOTES

1. Where a component is subjected to axial tensile, axial compressive, bending or shear stress, F_c is to be calculated in the normal manner.
2. Where a component is subjected to a combination of co-existent stresses, F_c is the combined stress which is to be calculated as follows:

Combined bending and tension

$F_c = 1{,}25 f_c + f_{bt}$

Combined bending and compression

$F_c = f_c + f_{bc}$

Combined bending, tension and shear

$$F_c = \sqrt{(1{,}25\, f_t + f_{bt})^2 + 3\, f_q^2}$$

Combined bending, compression and shear

$$F_c = \sqrt{(f_c + f_{bc})^2 + 3\, f_q^2}$$

where

F_c is the calculated stress
f_t is the calculated axial tensile stress
f_c is the calculated axial compressive stress
f_{bt} is the calculated maximum tensile stress due to bending about both principal axes
f_{bc} is the calculated maximum compressive stress due to bending about both principal axes
f_q is the calculated shear stress
Y is the specified 0,2 per cent proof stress for the material

Part 9, Chapter 1

General Requirements for Machinery

Effective date 1 July 2011

Section 1
General requirements

1.1 Application

1.1.1 Parts 9 to 16 apply to the design, construction, installation and testing of:

- Main propulsion machinery systems
- Essential auxiliary machinery systems ~~having powers in excess of 110 kW~~ , except where stated otherwise.
- Steering and manoeuvring systems

together with their associated equipment, pressure plant, piping systems, control engineering and electrical engineering systems for the craft types stated in Pt 1, Ch 2,1.

1.1.3 Requirements for craft which are not required to comply with the IMO Code for High Speed Craft are given at the end of each Chapter. Requirements for service craft, yachts of 24 m or greater and other craft types have been included in these ~~alternative~~ requirements. For the purposes of Parts 9 to 16, small craft are service craft of less than 24 m in length.

Effective date 1 July 2011

Section 3
Certification of Materials

3.1 Materials of construction

3.1.2 Materials used in the construction of machinery and its installation are not to contain asbestos. ~~should not be a recognised hazard to personnel. This includes the prohibition of asbestos except in the following applications:~~

~~(a) Vanes used in rotary vane compressors and rotary vane pumps.~~

~~(b) Watertight joints and linings used for the circulation of fluids when at high temperature (in excess of 350°C) or pressure (in excess of 70 bar (7 MPa)) there is a risk of fire, corrosion or toxicity.~~

~~(c) Supple and flexible thermal insulation assemblies used for temperatures above 1000°C.~~

Part 10, Chapter 1

Diesel Engines

Effective date 1 July 2011

Section 14
Program for trials of diesel engines to assess operational capability

14.2 Shipboard trials

Table 1.14.2 Scope of shipboard trials for diesel engines *(Part only shown)*

Single ~~main~~ engine~~s~~ ~~solely~~ driving generator~~s~~ for propulsion only

Part 12, Chapter 2

Waterjet Systems

Existing Part 12, Chapter 2 has been deleted in its entirety.

Effective date 1 July 2011

■ *Section 1* Scope

1.1 General

1.1.1 For the purposes of these Rules, a waterjet propulsion unit is described as a machine which takes in water, by means of a suitable inlet and conduit, and accelerates the mass of water using an impeller and nozzle to form a jet propulsion system. The waterjet system comprises the unit and its associated actuation and control devices. The detail of the prime mover is excluded but not its effect on the waterjet system.

1.1.2 This Chapter defines the requirements for the design and service life of marine waterjet propulsion systems and is to be read in conjunction with the General Requirements for the Design and Construction of Machinery in Chapter 1.

1.1.3 The requirements for a fixed or steerable waterjet propulsion system rated at 500 kW and above, which is integral with the ship's hull structure and forms a means of main propulsion, are detailed in this Chapter. This includes support arrangements, controls and the systems necessary to maintain operation and functionality of the waterjet unit.

1.1.4 These requirements relate to waterjets driven by axial or mixed flow pumps. Where units driven by radial flow pumps or inducers are proposed, details are to be submitted for consideration.

■ *Section 2* General requirements

2.1 Waterjet arrangement

2.1.1 In general, for a ship to be assigned an unrestricted service notation, a minimum of two waterjet systems is to be provided where these form the sole means of propulsion. For ships where a single waterjet system is the sole means of propulsion, a detailed engineering and safety justification is to be evaluated by LR, *see* 2.3.22. This evaluation process will include a risk analysis, using a recognised technique to verify that sufficient levels of redundancy and monitoring are incorporated in the waterjet unit's essential support systems and operating equipment.

2.1.2 Waterjet propulsion units are to be capable of continuous operation between their maximum and minimum output power rating at specified operating conditions, *see* Ch 1,3 and within the operational service profiles defined by 2.3.11 and 2.3.12.

2.1.3 It is the Shipbuilder's responsibility to ensure that all of the installed equipment is suitable for operation in the location and under the environmental conditions defined in Chapter 1. Where anticipated environmental conditions are outside these limits or where additional conditions are to be considered, such as vibration and impulsive accelerations, requirements and details of compliance are to be submitted to LR.

2.2 Plans to be submitted

2.2.1 Plans, in triplicate, and information as detailed below and in 2.3 and 2.4 are to be submitted for consideration.

2.2.2 General arrangement plans showing details of the following:

(a) Shafting assembly indicating bearing positions.
(b) Steering assembly.
(c) Reversing assembly.
(d) Shaft sealing arrangement assembly.
(e) Longitudinal section of the complete waterjet unit.

2.2.3 Detailed and dimensioned plans indicating scantlings, materials of construction and, where applicable, surface finish of the following:

(a) Arrangement of the system, including the intended method of attachment to the hull and building-in, tunnel geometry, shell openings, method of stiffening, reinforcement, etc.
(b) All torque transmitting components, including the shafting system, impeller and stator if fitted.
(c) Steering components, together with a description and line diagram of the control circuit. This is to include steerable exit waterjet nozzles where fitted.
(d) Components of the retractable buckets where these are used for providing astern thrust.
(e) The bearing or bearings absorbing the thrust and supporting the impeller, together with the method of lubrication.
(f) Details of any shafting support or guide vanes used in the waterjet system.

2.2.4 Schematic plans of the lubrication and hydraulics required for steering/reversing systems, together with pipe material, relief valves and the working pressures required.

2.3 Calculations and information

2.3.1 Strength calculations based on fatigue considerations incorporating the maximum continuous torque rating and the most 'onerous' operating condition, *see* 2.3.12, including any short-term high power operation, and including the effects of mean and fluctuating loads, transitory loadings, residual stress allowances, and stress raisers, for the following components:

(a) Impeller, stator and any bolting arrangements supporting propulsion or steering loads.
(b) Shaft supports and coupling arrangements.
(c) Inlet guide vanes, if fitted.
(d) Steering components, including the lugs of steerable nozzles where fitted.
(e) Retractable buckets and associated mechanisms which are used to provide astern thrust. A calculation of the hydrodynamic transient loads is to be made for each design and is to include the full ahead to full astern condition. The calculation procedure used is to be supported, where possible, with full scale or model test data, or satisfactory service experience, to validate the design method.

2.3.2 Calculations supporting the connection method of the impeller to the shaft including details of the fit, push-up, securing, bolting arrangements, etc. In addition, where lengths of shafts are joined using couplings of the shrunk element type, full particulars of the method of achieving the grip force.

2.3.3 Calculations relating to the design of the shaftline as evidence of compliance with Pt 11, Ch 2.

2.3.4 Torsional vibration calculations of the complete dynamic system in accordance with the relevant requirements included in Pt 13, Ch 1.

2.3.5 Shaft lateral vibration calculations where required by Pt 13, Ch 3.

2.3.6 Calculations of the tunnel strength and supporting structure.

2.3.7 A calculation to determine the stresses within the impeller blade.

2.3.8 A calculation of the blade natural frequency for the impeller blades.

2.3.9 A calculation of the relative blade passing frequency between the rotor and stator blades.

2.3.10 The value of the fluctuating stresses during one revolution of the impeller and from transient loadings.

2.3.11 Details of the power/speed range of operation, indicating the maximum continuous torque rating, together with the associated thrusts; this information may be presented in the form of a characteristic curve for the waterjet.

2.3.12 The waterjet thrust for the assessment of the strength condition being considered is to be as follows:

(a) For ships which are intended to operate predominantly in a free-running condition and at steady service conditions, the waterjet thrust is to correspond to the absorption of the maximum continuous shaft power and corresponding revolutions per minute, giving the maximum torque for which the shaft system is approved.
(b) For ships which are designed for several operating conditions, the maximum thrust associated with these conditions and the absorption of the corresponding power, in addition to the maximum continuous powering condition, are to be used in the calculation.
(c) The justification for the thrust selected is to be submitted for consideration in the approval process and this is to include the ship type and the ship speed at the conditions considered.

2.3.13 A justification that the waterjet system will meet the self-priming criteria, *see* 3.1.6.

2.3.14 Specifications of materials and NDE procedures for components essential for propulsion and steering operation and, in the case of the impeller and stator, the yield strength and the fatigue characteristics of the material intended for their manufacture.

2.3.15 A detailed weld specification where an impeller has welded blades.

2.3.16 Full details of the means of corrosion protection in the case of carbon or carbon manganese steel shafts. Alternatively, where it is proposed to use composite shafts, details of the connections at flanges, materials, resin, lay-up procedures, quality control procedures and documentary evidence of fatigue endurance strength is to be provided.

2.3.17 Dry impeller mass and polar moment of inertia.

2.3.18 The prime mover type and designation.

2.3.19 Details of the control engineering aspects of the system design in accordance with Pt 16, Ch 1.

2.3.20 The tolerance specification, agreed between the manufacturer and the Shipbuilder or Owner, to which the components of the unit are to be manufactured is to be defined together with a justification.

2.3.21 Details of the waterjet's loading reactions together with the positions of application within the hull and is to include the maximum applied thrust, tunnel pressures, moments and forces imposed on the ship.

2.3.22 The waterjet unit's rated flow and head.

2.3.23 Where an engineering and safety justification report is required, the following supporting information is to be submitted:

- A Failure Mode and Effects Analysis report (FMEA), *see* 2.4.
- Design standards and assumptions.
- Limiting operating parameters.
- A statement and evidence in respect of the anticipated reliability of any non-duplicated components.

2.3.24 Recommended installation, inspection, maintenance and component replacement procedures. This is to include any in-water engineering procedures where recommended by the waterjet manufacturer.

2.3.25 All transient loads which the steering unit is likely to experience from manoeuvring, accelerating, decelerating and the sea conditions.

2.4 Failure Mode and Effects Analysis (FMEA)

2.4.1 An FMEA is to be carried out where a single waterjet system is the ship's sole means of propulsion, *see* 2.2.3. The FMEA is to identify components where a single failure could cause the loss of all propulsion and/or steering capability and the proposed arrangements for preventing and mitigating the effects of such a failure.

2.4.2 The FMEA is to be carried out using the format presented in Table 22.2.1 in Pt 5, Ch 22 of the *Rules and Regulations for the Classification of Ships,* hereinafter referred to as the Rules for Ships or an equivalent format that addresses the same reliability issues. Analyses in accordance with IEC 60812 *Analysis for System Reliability – Procedure for Failure Mode and Effects Analysis*, or the IMO Code of Safety for High Speed Craft, 2000, Annex 4 – *Procedures for Failure Mode and Effects Analysis*, would be acceptable.

2.4.3 The FMEA is to be organised in terms of equipment and function. The effects of item failures at a stated level and at higher levels are to be analysed to determine these effects on the system as a whole. Actions for mitigation of the effects of failure are to be determined, *see* 2.4.1.

2.4.4 The FMEA is to:

(a) identify the equipment or sub-system and mode of operation;
(b) identify potential failure modes and their causes;
(c) evaluate the effects on the system of each failure mode;
(d) identify measures for reducing the risks associated with each failure mode;
(e) identify measures for preventing failure; and
(f) identify trials and testing necessary to prove conclusions.

2.4.5 At sub-system level it is acceptable, for the purposes of these Rules, to consider failure of equipment items and their functions. It is not required that the failure of components within that equipment item be analysed, *see Pt 5* Ch 22, 2.1.5 of the Rules for Ships.

2.4.6 Where a FMEA is used for consideration of systems that depend on software-based functions for control or co-ordination, the analysis is to investigate failure of the functions rather than a specific analysis of the software code itself.

■ *Section 3*

Design requirements

3.1 General

3.1.1 The arrangement of waterjet units is to be such that the ship can be satisfactorily manoeuvred to a declared performance capability. The operating conditions covered are to include the following:

(a) Maximum continuous shaft power/speed to the impeller in the ahead condition at the declared steering angles and conditions.
(b) Manoeuvring speeds of the impeller shaft and/or reversing mechanism in the ahead and astern direction at the declared steering angles and sea conditions.
(c) The stopping manoeuvre described in Pt 9, Ch 2, 8.2.
(d) Astern running conditions for the craft.

3.1.2 The mean loadings are those loadings induced by the waterjet absorbing the mean torque supplied by the prime mover.

3.1.3 Fluctuating loads are defined as those loads which occur during one revolution of the impeller due to cyclic variations. For example, the spatial flow variations and torsional vibration at nominally steady state operating conditions.

3.1.4 Transient loads are defined as those loadings resulting from acceleration and deceleration of the ship, manoeuvring, seaway conditions and other similar forms of loading. This also includes any significant back-pressure effects developed from the operation of the reversing bucket, if fitted.

3.1.5 To ensure self-priming of the waterjet unit, the shaft centreline of the unit is to be lower than the light draught static waterline of the ship. In cases where this is either impracticable or undesirable, the distance of the impeller shaft centreline above the ship's light draught waterline is to be less than or equal to 10 per cent of the pump inlet diameter.

3.1.6 Provision is to be made to allow for the in-service visual inspection of the complete blade surfaces of both the impeller and stator blades using either a direct visual or borescope inspection technique.

3.2 Shaftline

3.2.1 The diameter of the shaftline components are to comply with Pt 11, Ch 2. For calculation purposes the shaft carrying the impeller is to be taken as equivalent to a screwshaft.

3.2.2 Where it is proposed to use carbon or carbon manganese steel shafts which may be in contact with seawater, these are to be protected.

3.2.3 The diameter of unprotected screwshafts of corrosion-resistant material is not to be less than that given in Pt 11, Ch 2,4.4.7.

3.2.4 The use of composite shafts is permitted, *see* 2.3.16.

3.2.5 Where lengths of shafts are joined using couplings of the shrunk element type, a factor of safety, based upon the mean plus the vibratory and transient torques, against slippage of 2,0 is to be achieved for couplings which are located inboard and 2,5 for couplings which are located outboard.

3.2.6 Where shaftline components are bolted together, the design of the bolted connection should demonstrate a factor of safety of 1,5 when considered in the context of the mean, fluctuating and transitory loadings.

3.2.7 If a keyed fitting of the impeller to the shaft is contemplated, then the requirements of Pt 11, Ch 2,4.12 are to be satisfied.

3.2.8 Where it is proposed to fit a keyless impeller, the fitting is to comply with the requirements of Pt 12, Ch 1,4.2, as applicable, excluding the requirements for Ice Class. Use of the words ‘propeller’ and ‘screwshaft’ are to be taken as meaning ‘impeller’ and ‘impellershaft’ respectively.

3.3 Shaft support system and guide vanes

3.3.1 In cases where the shaft requires support from the tunnel walls ahead of the impeller or, alternatively, where guide vanes are required to assist the flow around a bend in the ducting system, the supports or guide vanes are to be suitably aligned to the flow and have suitably rounded leading and trailing edges or be of an aerofoil section.

3.3.2 In general, the fillet radius should be greater than or equal to the maximum thickness of the vane or support at that location. Smaller radii may be considered, for which the results of an approved measurement programme or calculation procedure are to be submitted. In all cases, a factor of safety of at least 1,5 is to be demonstrated for the maximum designed operating conditions.

3.3.3 A facility for the inspection of the supports or guide vanes is to be provided, which will allow either direct visual or borescope inspection of these components and their transition to other members.

3.4 Impeller

3.4.1 A calculation to determine the stresses within the impeller blades is to be carried out which takes into account the mean blade loading, fluctuating loadings, transient loads and centrifugal force. The computations may be accomplished by either classical methods or numerical analysis. Designs of waterjet systems which have been based on a combination of computational fluid dynamics and finite element methods will be considered. However, it will be necessary to demonstrate to the satisfaction of LR that the formulation of the methods used has been correlated with previous full scale measurement or other calculation experience.

3.4.2 For the purposes of the calculation required by this sub-Section, the fluctuating stresses during one revolution of the impeller is to be taken as 20 per cent of the maximum mean stress, and the stresses from transient loadings are to be taken as 15 per cent of the hydrodynamic mean stress, unless otherwise specified by the designer.

3.4.3 The fatigue assessment of the impeller blades is to be based on the stress in the root sections, excluding the influence of the blade root fillets. This assessment is to include the following components:

- the maximum stresses derived from the mean loading, including both the hydrodynamic and centrifugal components;
- the amplitude of the fluctuating stresses during one revolution of the impeller;
- the stresses derived from transient loading and an allowance for any residual stresses in the material.

It is permissible to combine the variable components of stress in a linear fatigue damage accumulation assessment procedure. A factor of safety of at least 1,5 against fatigue failure is to be demonstrated for the maximum continuous rating condition or any other more onerous condition, *see* 3.1.1.

3.4.4 In general, the fillet radius is to be greater than the maximum thickness of the impeller blade at that location. Composite radiused fillets or elliptical fillets which provide an improved stress concentration factor are preferred.

3.4.5 Where an impeller has bolted-on blades, consideration is to be given to the distribution of stress in the palms of the blade and in the hub and bolting arrangements.

3.4.6 Where an impeller has welded blades, the welds are to be of the full penetration type or of equivalent strength. Where laser welding is to be used, details are to be submitted for consideration.

3.4.7 The blades are to be provided with hydrodynamically faired leading and trailing edges which may be either of simple radius or of a more complex aerofoil edge form. The tip clearance, whilst being kept to a minimum for hydrodynamic purposes, is to be sufficient to allow for any transient vibrational behaviour, axial shaft movement or differential thermal expansion.

3.4.8 A calculation of the blade natural frequency for the impeller blades is to be undertaken. The fundamental natural frequency in water of the blade is to be shown to lie outside any expected excitation frequencies within a speed range of the waterjet unit and up to 10 per cent above the maximum impeller speed.

3.5 Stator

3.5.1 The stator blades, where fitted, are to be designed to be capable of withstanding the combined hydrodynamic mean, fluctuating, transient and mechanical loads, including any loads transmitted via shaft bearings, developed by the unit and reacted through the blades when the impeller is absorbing full power. Consideration is to be given to situations when the vessel is either free running or in a condition specified by 3.1.1 or undergoing stopping, accelerating or decelerating manoeuvres. A factor of safety against mechanical failure by yielding of the blades of 1,5 is to be demonstrated.

3.5.2 In general, the fillet radius is to be greater than the maximum thickness of the blade at that location. Composite radiused fillets or elliptical fillets which provide improved stress concentration factors are preferred.

3.5.3 If the stator ring comprises a segmented assembly, then consideration is also to be given to the distribution of stress in the various adjacent members of the overall assembly.

3.5.4 A calculation of the relative blade passing frequency between the rotor and stator blades is to demonstrate that this does not coincide with the natural frequency of the stator blades over the speed range of the waterjet unit and up to 10 per cent above maximum impeller speed.

3.5.5 The stator blades are to be provided with hydrodynamically faired leading edges which may have either a simple radius or a more complex aerofoil edge form.

3.5.6 Where the stator blading assembly forms part of the nozzle, the requirements of 3.7 are to be considered in association with those for the stator assembly.

3.6 Tunnel and securing arrangements

3.6.1 The tunnel is to be adequately supported, framed and fully integrated into the hull structure. The critical locations and integrity of the supports and framing are to be as specified in the FMEA and agreed by the Shipbuilder and LR.

3.6.2 The tunnel and supporting structure scantlings are to be not less than the Rule requirements for the surrounding structure. The strength of the hull structure in way of tunnel(s) is to be maintained. The structure is to be adequately reinforced and compensated as necessary. All openings are to be suitably reinforced and have radiused corners.

3.6.3 Consideration is to be given to providing the inlet to the tunnel with a suitable guard to prevent the ingress of large objects into the rotodynamic machinery. The dimensions of this guard, if fitted, are to strike a balance between undue efficiency loss due to flow restriction and viscous losses, the size of object allowed to pass and the susceptibility to clog with weed and other flow-restricting matter.

3.6.4 The inlet profile of the tunnel is to be designed so as to provide a smooth uptake of the water over the range of vessel operating trims and avoid significant separation and/or cavitation of the flow which may then pass downstream into the rotating machinery.

3.6.5 Design consideration is to take account of pressures which could develop as a result of a duct blockage as well as in relation to the axial location of rotating parts.

3.6.6 The strength of the tunnel and supporting structure are to be examined by direct calculation procedures.

3.7 Nozzle/steering arrangements

3.7.1 In general, the steering systems and components are to comply with the requirements of Pt 14, Ch 1.

3.7.2 Nozzles can be either of a fixed or steerable form. The design of the nozzle is to take into account fully the change in pressure distribution along its inner surface together with the other mechanical loads (e.g. stator assembly loads) and transient loads caused by the flow directing attachments which may be reacted through the body of the nozzle. In this analysis, the changes to the pressure distribution caused by transient manoeuvres are to be considered.

3.7.3 In addition to the requirements of Pt 14, Ch 1, the steering mechanism and bucket are to be capable of maintaining the manoeuvrability of the ship in terms of turning circle, zig-zag and stopping requirements within the limits defined by IMO Resolution MSC.137(76), Standards for Ship Manoeuvrability.

3.7.4 Consideration is to be given to all transient loads which the steering unit is likely to experience from manoeuvring, accelerating, decelerating and the sea conditions.

3.7.5 The nozzle/bucket is to be given mechanical protection by the Shipbuilder from other impact damage such as collision.

3.8 Bolts

3.8.1 Detailed consideration and analysis is to be given to essential bolting arrangements in critical locations as specified in the FMEA and where indicated by the Manufacturer or Shipbuilder and agreed by LR. These are to include bolts used in the securing of blades or guide vanes, assembly of the unit in the ship and any conduit components.

Section 4

Piping systems

4.1 General

4.1.1 The piping systems for a waterjet unit are to comply with the general requirements of Pt 15, Ch 3.

4.1.2 Lubricating and hydraulic oil systems and standby arrangements are to comply with the requirements of Pt 15, Ch 3; in addition, steering hydraulic systems are to comply with the applicable requirements of Pt 14, Ch 1.

Section 5

Control and monitoring

5.1 General

5.1.1 In addition to this Section, the control engineering systems are to comply with Pt 16, Ch 1.

5.1.2 Steering control for the waterjet is to be provided at the ship's normal conning stations.

5.1.3 For waterjets used as the only means of propulsion and steering, a standby or alternative power source for the actuating device, that controls the angular position and/or the reversing angle, is to be provided. Automatic start of the standby pump supplying hydraulic power for steering and reversing is to be provided.

5.1.4 Means are to be provided at each control station to stop each waterjet.

5.2 Monitoring and alarms

5.2.1 In addition to the requirements of Pt 14, Ch 1, alarms and monitoring requirements are indicated in 5.2.2 to 5.2.4 and Table 12.5.1.

5.2.2 An indication of the angular position of the nozzle is to be provided at each station from which it is possible to control the direction of thrust from the units.

5.2.3 An indication of both the required and actual reversing bucket position is to be provided at each station from which it is possible to control the reversal of thrust.

5.2.4 All alarms associated with waterjet unit faults are to be indicated individually at the control stations and in accordance with the alarm system specified by Pt 16, Ch 1.

Section 6

Electrical systems

6.1 Installation and distribution arrangements

6.1.1 The electrical installation is to comply with the relevant sections of Pt 16, Ch 2.

6.1.2 Waterjet auxiliaries and controls are to be served by individual circuits. Services that are duplicated are to be separated throughout their length as widely as practicable and without the use of common feeders, transformers, converters, protective devices or control circuits.

Table 12.5.1 Alarms

Item	Alarm	Note
Hydraulic system pressure	Low	–
Hydraulic oil supply tank level	Low	–
Hydraulic oil temperature	High	Where an oil cooler is fitted
Lubricating oil temperature	High	
Lubricating oil pressure	Low	In forced lubrication systems
Lubricating oil tank level	Low	Where a tank is provided
Ratio of jet rpm/vessel speed	High	Only if installed power per jet > 4 MW
Control system failure	Fault	Includes follow-up failure of steering or reversing system
Control system power supply	Failure	

■ Section 7
Inspection, testing and fitting of waterjets

7.1 General

7.1.1 The finished impeller is to be statically balanced on completion of the manufacturing process and meet the requirements of ISO 1940 or an alternative standard acceptable to LR. In the case where the blade tip speed is greater than 60 m/s, dynamic balancing is required unless otherwise agreed by the Manufacturer and LR.

7.1.2 The following tests, markings and inspections are to be carried out in the presence of the Surveyor:

(a) The balancing of the impeller or the blades.
(b) Non-destructive examination of the impeller blades and the principal component parts of the propulsion system: for austenitic stainless steels, *see* Ch 4,8, and for aluminium alloys, *see* Ch 8,3, of the Rules for Materials.
(c) The quality of the fit of the impeller boss on the shaft taper.
(d) The fitting of the impeller to the shaft and its subsequent functional testing.
(e) The finished surfaces of the impeller boss, hub, conical bores, fillets, cones and blade surfaces are to be shown to conform to the tolerances specified on the impeller drawing.

7.1.3 Bolts and nuts in critical locations, as specified in the FMEA and where indicated by the Manufacturer or Shipbuilder and agreed by LR, are to be equipped with adequate securing arrangements to the satisfaction of the LR Surveyor.

7.2 Shop tests and installation of waterjet systems

7.2.1 The completed waterjet unit is to undergo a tightness test in which an internal hydrostatic pressure of 1,5 bar above the maximum working pressure of the unit is to be applied.

7.2.2 In cases where the impeller is fitted to the shaft using an interference fit, the bedding of the impeller with the shaft is to be demonstrated in the shop to the satisfaction of the LR Surveyor. Sufficient time is to be allowed for the temperature of the components to equalise before bedding. A contact marking between the bore of the impeller boss and the shaft surface of better than 80 per cent is to be demonstrated when the contact marking ink is spread thinly on the surface of the shaft. Alternative means for demonstrating the bedding of the impeller will be considered.

7.2.3 Means are to be provided to indicate the relative axial position of the impeller boss on the shaft. Permanent reference marks are to be made on the impeller boss, shaft and any nut to indicate angular and axial positioning of the impeller. Care is to be taken in marking the inboard end of the shaft taper to minimise stress-raising effects.

7.2.4 A copy of the fitting curve relative to temperature and means for determining any subsequent movement are to be placed on board.

7.2.5 The impeller running clearances are to be checked following the installation of the unit in the ship.

7.2.6 The thrust bearing clearances in the waterjet system are to be verified against the required design values. This is to be done following the installation of the unit in the ship.

7.2.7 The piping systems are to be adequately flushed in accordance with the Manufacturer's recommendations and the final levels of contamination recorded. Similarly, pressure testing of the piping systems is to comply with Pt 15, Ch 1.

7.3 Sea trial requirements

7.3.1 The following requirements are to be complied with:

- Pt 9, Ch 2,8.2 for sea trials.
- Pt 14, Ch 1,4.4 for steering trials.

In addition, the general design capability specified in 3.1.1 is to be demonstrated to the Surveyor's satisfaction.

7.3.2 The control systems relating to the correct functioning of the waterjet is to be the subject of harbour and then sea trials. Demonstration of the requirements of Pt 16, Ch 1 is required and the design combinations of control functions are to be undertaken during the trials programme.

7.3.3 On sea trials and under free running conditions, the relationship between ship speed and impeller rotational speed is to be verified against the waterjet's design basis.

7.3.4 Any trials and testing identified from the FMEA report, *see* 2.4, are to be carried out.

■ Section 8
Installation, maintenance and replacement

8.1 General

8.1.1 All waterjet system propulsion units are to be provided with a copy of the Manufacturer's installation and maintenance manual that is pertinent to the actual equipment. *See* 2.3.24.

8.1.2 The manual required by 8.1.1 is to be placed on board and is to contain the following information:

(a) Description of the waterjet propulsion system with details of function and design operating limits. This is also to include details of support systems such as lubrication, cooling and condition monitoring arrangements.
(b) Identification of all components together with details of any that have a defined maximum operating life.
(c) Instructions for installation of the system on board ship with details of any required specialised equipment.
(d) Instructions for commissioning at initial installation and following maintenance.
(e) Maintenance and service instructions to include inspection/renewal of bearings and sealing arrangements. This is also to include component fitting procedures, clearance measurements and lubricating oil treatment where applicable.
(f) Actions required in the event of fault/failure conditions being detected.
(g) Precautions to be taken by personnel working during installation and maintenance.

Part 14, Chapter 1

Steering Systems

Effective date 1 July 2011

■ *Section 6*
Control, monitoring and electrical equipment

6.2 Monitoring

6.2.4 Steering control systems are to be monitored and an audible and visual alarm is to be initiated on the navigation bridge in the event of:

- failure of the control system, including command and fee back circuits; or
- unacceptable deviation between the rudder order and actual rudder position and/or unacceptable delay in response to changes in the rudder order.

Table 1.6.1 Alarms

Item	Alarm	Note
Angular position of the Steering Mechanism	— Failure	Indication, *see* ~~6.2.2~~ 6.1.6 *See* 6.2.4
Steering power units, power	Failure	—
Steering motors	Overload Single phase	For alarm and running indication locations, *see* 6.3.2 and 6.3.3
Control system	Failure	*See* 6.2.4
Control system power	Failure	—
Steering gear hydraulic oil level	Low	Each reservoir to be be monitored. For Alarm locations, *see* 6.3.4.
Auto pilot	Failure	Running indication
Hydraulic oil temperature	High	Where oil cooler is fitted
Hydraulic lock	Fault	Where more than one system (either power or control) can be operated simultaneously each each system is to be monitored, *see* Note
Hydraulic oil filter differential pressure	High	When oil filters are fitted

NOTE
This alarm is to identify the system at fault and is to be activated when (for example):
- position of the variable displacement pump control system does not correspond with given order; or
- incorrect position of 3-way full flow valve or similar in constant delivery pump system is detected.

Effective date 1 July 2011

■ *Section 7*
Requirements for craft which are not required to comply with the HSC Code

7.1 Introduction

~~*7.1.1* In craft over 50 m in length, the main steering gear is to be power operated.~~

7.1.1 The requirements of Sections 1 to 6 of this Chapter apply, except where modified by this Section.

~~*7.1.2* Service craft of length 50 m or less, or sailing yachts of length 50 m or less, may have manual steering. Where wheel steering is fitted an alternative means of steering (which may be a hand tiller) is to be readily available, and the performance of both systems is to be in accordance with 7.2.6.~~

7.2 Design and performance

7.2.1 In craft over 50 m in length, the main steering system is to be power operated.

7.2.2 Service craft of length 50 m or less, or sailing yachts of length 50 m or less, may have manual steering. Where wheel steering is fitted, an alternative means of steering (which may be a hand tiller) is to be readily available, and the performance of both systems is to be in accordance with 7.2.6.

Existing paragraphs 7.2.1 *to* 7.2.6 *have been renumbered* 7.2.3 *to* 7.2.8.

Part 15, Chapter 1

Piping Design Requirements

Effective date 1 July 2011

Section 2

Details to be submitted

2.1 Plans and information

2.1.3 The following diagrammatic plans including details of the material and pipe dimensions/thickness:

- Bilge and ballast system including the capacities of the pumps on bilge service.
- Lubricating oil systems.
- Flammable liquids used for ~~power transmission,~~ control and heating systems.
- Power transmission systems for services essential for safety or for the operation of the craft at sea.
- Cooling water systems for main and auxiliary services.
- Compressed air systems for main and auxiliary services.
- Steam systems with a design pressure above 7 bar.

Effective date 1 July 2011

Section 9

Austenitic Stainless steel

9.1 General

~~**Table 1.9.1 Minimum thickness for stainless steel pipes**~~

~~Standard pipe sizes (outside diameter)~~			~~Minimum nominal thickness~~
~~mm~~		~~mm~~	~~mm~~
~~8,0~~	~~to~~	~~10,0~~	~~0,8~~
~~12,0~~	~~to~~	~~20,0~~	~~1,0~~
~~25,0~~	~~to~~	~~44,5~~	~~1,2~~
~~50,0~~	~~to~~	~~76,1~~	~~1,5~~
~~88,9~~	~~to~~	~~108,0~~	~~2,0~~
~~133,0~~	~~to~~	~~159,0~~	~~2,5~~
~~193,7~~	~~to~~	~~267,0~~	~~3,0~~
~~273,0~~	~~to~~	~~457,2~~	~~3,5~~

Table 1.9.1 Minimum thickness for austenitic stainless steel pipes

Standard pipe sizes (outside diameter)			Minimum nominal thickness
mm		mm	mm
10,2	to	17,2	1,0
21,3	to	48,3	1,6
60,3	to	88,9	2,0
114,3	to	168,3	2,3
219,1			2,6
273,0			2,9
323,9	to	406,4	3,6
over	406,4		4,0

NOTE
The external diameters and thicknesses have been selected from ISO-Standard 1127:1980. Diameters and thicknesses according to other National or International Standards may be accepted.

Part 15, Chapter 2

Hull Piping Systems

Effective date 1 July 2011

■ *Section 11*

Air, overflow and sounding pipes

11.4 Air pipe closing appliances

11.4.4 Air pipe automatic closing devices shall be so designed that they will withstand both ambient conditions as indicated in Pt 9, Ch 1, 4.4 and designed working conditions, and be suitable for use at inclinations up to and including ± 40°.

11.4.5 Air pipe automatic closing devices shall be constructed to allow inspection of the closure and the inside of the casing, as well as changing the seals.

11.4.6 Efficient ball or float seating arrangements are to be provided for the closures. Bars, cages or other devices are to be provided to prevent the ball or float from contacting the inner chamber in its normal state, and made in such a way that the ball or float is not damaged when subjected to liquid impact due to a tank being overfilled.

11.4.7 Air pipe automatic closing devices are to be self-draining.

11.4.8 The clear area through an air pipe closing device in the open position shall be at least equal to the area of the inlet.

11.4.9 In the case of air pipe closing devices of the float type, suitable guides are to be provided to ensure unobstructed operation under all working conditions of heel and trim.

11.4.10 The maximum allowable tolerances for wall thickness of floats should not exceed ±10 per cent of thickness.

11.4.11 The inner and the outer chambers of an automatic air pipe head are to be of a minimum thickness of 6 mm.

11.4.12 Casings of air pipe closing devices are to be of approved metallic materials adequately protected against corrosion.

11.4.13 For galvanised steel air pipe heads, the zinc coating is to be applied by the hot method and the thickness is to be 70 to 100 microns.

11.4.14 For areas of the head susceptible to erosion (e.g. those parts directly subjected to ballast water impact when the tank is being pressed up, for example the inner chamber area above the air pipe, plus an overlap of 10° or more either side) an additional harder coating should be applied. This is to be an aluminium bearing epoxy, or other equivalent coating, applied over the zinc.

■ *Section 15*

Requirements for yachts and service craft of 24m or greater in length, which are not required to comply with the HSC Code

15.1 General

15.1.1 The requirements of Sections 1, 2, 3, 11 and 12 of this Chapter are generally applicable. The remaining Sections 4 to 10 of this Chapter concerning the requirements for bilge pumping and drainage systems are replaced by the requirements given in 15.2 to 15.28.

15.2 Bilge ~~pumping and drainage~~ systems and pumping

~~*15.2.1* The following requirements replace Sections 4 to 10 of this Chapter.~~

15.2.1 Where it is intended to carry vehicles with fuel in their tanks having a flashpoint less than 60°C for their own propulsion and having re-fuelling facilities for such vehicles or when only providing re-fuelling facilities, a separate bilge system is to be provided.

15.2.2 The bilge system is to be designed to prevent pumping of flammable liquids through piping and pumps in machinery, accommodation or any other spaces where a source of ignition may exist.

Part 15, Chapter 3

Machinery Piping Systems

Effective date 1 July 2011

■ *Section 4* Oil fuel systems

4.6 Relief valves on pumps

4.6.1 All pumps which are capable of developing a pressure exceeding the design pressure of the system are to be provided with relief valves. Each relief valve is to be in closed circuit, i.e. arranged to discharge back to the suction side of the pump and effectively to limit the pump discharge pressure to the design pressure of the system.

■ *Section 6* Lubricating/hydraulic oil systems

6.2 Arrangements for ~~other~~ hydraulic and flammable oils

6.2.1 ~~The arrangements for storage, distribution and utilisation of other flammable oils employed under pressure in power transmission systems, control/activating and heating systems in locations where means of ignition are presentv1 are to comply with the applicable provisions of 6.1.~~

6.2.1 The requirements of this Section are applicable to flammable oils employed under pressure in power transmission, control, actuating and heating systems, and hydraulic media in systems which are providing essential services.

6.2.2 The arrangements for storage, distribution and utilisation of hydraulic and flammable oils employed in the systems defined in this sub-Section are to comply with the provisions of 6.1.

Part 16, Chapter 1

Control Engineering Systems

Effective date 1 July 2011

■ *Section 1* General Requirements

1.2 Plans and information

1.2.5 Programmable electronic systems. ~~(~~In addition to the documentation required by 1.2.2~~)~~, the following is to be submitted:

~~•~~(a) System requirements specification.

~~•~~(b) System integration plan, *see* ~~2.13.2~~ 2.14.2.

~~•~~(c) Failure Mode and Effects Analysis (FMEA), *see* ~~2.13.5~~ 2.14.5.

~~•~~(d) Details of the hardware configuration in the form of a system block diagram, including input/output schedules.

~~•~~(e) Hardware certification details, *see* 2.10.5 and ~~2.12.3~~ 2.13.3.

~~•~~(f) Software quality plans, including applicable procedures, *see* 2.10.25.

~~•~~(g) Factory acceptance, integration and sea trial test schedules for hardware and software.

~~•~~(h) Details of data storage arrangements, *see* 2.10.10 and ~~2.12.6~~ 2.13.6.

1.2.6 For wireless data communication equipment:

(a) Details of manufacturer's installation and maintenance recommendations;

(b) network plan with arrangement and type of aerials and identification of location;

(c) specification of wireless communication system protocols and management functions, *see* 2.12.4; and

(d) details of radio frequency and power levels, including details of those permitted by the National Administration.

Existing paragraphs 1.2.6 *to* 1.2.9 *have been renumbered* 1.2.7 *to* 1.2.10.

Effective date 1 July 2011

■ Section 1

General Requirements

1.2 Plans and information

1.2.2 A description of operation with explanatory diagrams together with line diagrams of control circuits, list of monitored, control and alarm points is required for the following machinery or equipment:

- Fixed water-based local application fire-fighting systems, *see* 2.9.
- Air compressors.
- Bilge systems.
- Controllable pitch propellers.
- Electric generating plant.
- Oil fuel transfer and storage systems.
- Propulsion machinery including essential auxiliaries.
- Steam raising plant (boilers and their ancillary equipment).
- Steering systems.
- Thermal fluid heaters.
- Thrust units.
- Valve position indicating systems.
- Waterjets for propulsion purposes.
- Windlasses.

■ Section 2

Essential features for control, alarm and safety systems

2.8 Fire detection alarm systems

2.8.7 Power supplies for the alarm system are to be in accordance with ~~2.3.10 and 2.3.11~~ Ch 2,16.1

2.10 Programmable electronic systems - General requirements

2.10.20 Display units are to comply with the requirements ~~International Electrotechnical Commission Standard IEC 60950:1991~~ of an acceptable National or International Standard e.g. IEC 60950:1999, *Safety of information technology equipment*~~, including electrical business equipment~~, in respect of emission of ionising radiation.

2.11 Data communication links

2.11.3 Loss of a data communication link is not to result in the loss of ability to operate any essential service by alternative means, *see also* ~~2.12.2~~ 2.13.2.

2.11.7 System self-monitoring capabilities are to be arranged to initiate transition to a defined safe state for the complete installation in the event of data communication failure, *see also* 2.5.5.

Existing paragraphs 2.11.7 *to* 2.11.10 *have been renumbered* 2.11.8 *to* 2.11.11.

2.12 Additional requirements for wireless data communication links

2.12.1 The requirements of this sub-Section are in addition to 2.11 and apply to systems incorporating wireless data communication links.

2.12.2 Wireless data communication links are not to be used for safety critical systems or essential services that are required for the propulsion or safety of the craft, except as permitted by 2.12.3.

2.12.3 For services not required to operate continuously, wireless data communication links may be considered where an alternative means of operation that can be brought into action within an acceptable period of time is provided.

2.12.4 Wireless data communication is to employ recognised international wireless communication system protocols that incorporate the following:

(a) Message integrity: fault prevention, detection, diagnosis and correction, ensuring that the received message is not corrupted or altered when compared to the transmitted message.
(b) Configuration and device authentication: is to permit connection only of devices that are included in the system design.
(c) Message encryption: protection of the confidentiality and/or criticality of the data content.
(d) Security management: protection of network assets and prevention of unauthorised access to network assets.

2.12.5 The wireless system is to comply with the radio frequency and power level requirements of the International Telecommunications Union and any requirements of the National Administration with which the craft is registered.

2.12.6 Compliance with different port state and local regulations pertaining to the use of radio-frequency transmission that would prohibit the operation of a wireless data communication link, due to frequency and power level restrictions, is not addressed by these requirements and is the responsibility of the Owner and Operator.

Existing sub-Sections 2.12 *to* 2.13 *have been renumbered* 2.13 *to* 2.14.

■ Section 6

Trials

6.1 General

6.1.4 Wireless data communication links are to be operational and tested during trials. Tests are to demonstrate that radio-frequency transmission does not interfere with the operation of equipment required by this Chapter or other Sections of the Rules and does not itself malfunction as a result of electromagnetic interference during expected operating conditions. Reversionary modes are to be activated to demonstrate continued safe and effective operation in the event of fault conditions.

Part 16, Chapter 2

Electrical Engineering

Effective date 1 July 2011

■ *Section 2*
Main source of electrical power

2.3 Starting arrangements

2.3.2 Where the emergency source of electrical power is required to be used to restore propulsion from a 'dead craft condition', the emergency generator is to be capable of providing initial starting energy for the propulsion machinery within 30 minutes of the 'dead craft condition'. The emergency generator capacity is to be sufficient for restoring propulsion in addition to supplying those services in ~~Section 3~~ 3.2.7(a), 3.2.7(b), 3.2.7(c) for passenger craft and yachts greater than 500gt; or 3.3.7(a), 3.3.7(b), 3.3.7(c) and 3.3.7(d)(i) and (vi) for craft required to comply with HSC code; or 3.4.3(a) to (e) and (f) (i) as applicable. *See* Pt 10, Ch 1,7.1.1 and Ch 2,6.1.1 for starting arrangements.

■ *Section 5*
Supply and distribution

5.3 Isolation and switching

5.3.5 Where arrangements are in place for automatic changeover between two or more supplies of electrical power in the event of failure of one supply, the arrangements are to be such that a fault in one feeder does not result in the loss of all supplies to the automatic changeover switch.

Existing paragraphs 5.3.5 *to* 5.3.7 *have been renumbered* 5.3.6 *to* 5.3.8.

Part 16, Chapter 2
Electrical Engineering

Effective date 1 July 2011

■ *Section 10*

Electrical cables and busbar trunking systems (busways)

10.4 Operating temperature

~~**Table 2.10.2 Maximum rated conductor temperature**~~

~~Type of Insulating compound~~	~~Maximum rated conductor temperature °C~~	
	~~Normal operation~~	~~Short circuit~~
~~Thermoplastics:~~		
~~• Based upon polyvinyl chloride or co-polymer of vinyl chloride and vinyl acetate~~	~~60~~	~~150~~
~~• Based upon Polyethylene~~	~~60~~	~~130~~
~~Elastomeric or thermosettings:~~		
~~• Based upon ethylene propylene rubber or similar (EPM or EPDM)~~	~~85~~	~~250~~
~~• Based upon Chemically crosslinked polyethylene~~	~~85~~	~~250~~
~~• Based upon silicon rubber~~	~~95~~	~~To be submitted~~
~~Mineral~~	~~95~~	~~To be submitted~~

Table 2.10.2 Maximum rated conductor temperature

Type of Insulating compound	Maximum rated conductor temperature °C	
	Normal operation	Short-circuit
Thermoplastics:		
• Based upon polyvinyl chloride or co-polymer of vinyl chloride and vinyl acetate	70	150
Elastomeric or thermosetting:		
• Ethylene-propylene rubber or similar (EPM or EPDM)	90	250
• High modulus or hard grade ethylene propylene rubber	90	250
• Cross-linked polyethylene	90	250
• Ethylene-propylene rubber or similar (EPM or EPDM) halogen-free	90	250
• High modulus or hard grade halogen-free ethylene propylene rubber	90	250
• Halogen-free cross-linked polyethylene	90	250
• Cross-linked polyolefin material for halogen-free cables	90	250
• Silicon rubber	95	350
• Halogen-free silicone rubber	95	350

10.5 Construction

10.5.3 Where electric cables are required to be of a `fire resistant type', they are in addition to be easily distinguishable and to comply with the performance requirements of the appropriate part of IEC 60331: *Tests for electric cables under fire conditions – Circuit integrity*, when tested with a minimum flame application time of 90 minutes, as follows:

- IEC 60331-1, *Tests for electric cables under fire conditions – Circuit integrity – Part 1: Test method for fire with shock at a temperature of at least 830 °C for cables of rated voltage up to and including 0,6/1,0 kV and with an overall diameter exceeding 20 mm*.
- IEC 60331-21: *Procedures and requirements – Cables of rated voltage up to and including 0.6/1.0 kV*;
- IEC 60331-23: *Procedures and requirements – Electric data cables*; or
- IEC 60331-25: *Procedures and requirements – Optical fibre cables*. ~~or~~
- ~~IEC 60331-31: *Procedures and requirements – Cables of rated voltage up to and including 0.6/1.0 kV*, where the overall diameter of the cable exceeds 20 mm.~~

Table 2.10.3 Electric cable current ratings, normal operation, based on ambient 45°C

Nominal cross section	Continuous r.m.s current rating, in amperes								
	Thermoplastic, PVC, PE			EP rubber and crosslinked PE			Silicon rubber or mineral		
	single core	2 core	3 or 4 core	single core	2 core	3 or 4 core	single core	2 core	3 or 4 core
0,75	6	5	4	13	11	9	17	14	12
1	8	7	6	16	14	11	20	17	14
1,25	10	8	7	18	15	13	23	19	16
1,5	12	10	8	20	17	14	24	20	17
2	13	11	9	25	21	17	31	26	21
2,5	17	14	12	28	24	20	32	27	22
3,5	21	18	14	35	30	24	39	33	27
4	22	19	15	38	32	27	42	36	29
5,5	27	23	19	46	39	32	52	44	36
6	29	26	20	48	41	34	55	47	39
8	35	30	24	59	50	41	66	56	46
10	40	34	28	67	57	47	75	64	53
14	49	42	34	83	71	58	94	80	66
16	54	46	38	90	77	63	100	85	70
22	66	56	46	110	93	77	124	105	87
25	71	60	50	120	102	84	135	115	95
30	80	68	56	135	115	94	151	128	106
35	87	74	61	145	123	102	165	140	116
38	92	78	64	155	132	108	175	149	122
50	105	89	74	185	153	126	200	175	140
60	123	104	86	205	174	143	233	198	163
70	135	115	95	225	191	158	255	217	179
80	147	125	103	245	208	171	278	236	195
95	165	140	116	275	234	193	310	264	217
100	169	144	118	285	242	199	320	272	224
120	190	162	133	320	272	224	360	306	252
125	194	165	134	325	280	230	368	313	258
150	220	187	154	365	310	256	410	349	287
185	250	213	175	415	353	291	470	400	329
200	260	221	182	440	375	305	494	420	346
240	290	247	203	490	417	343	570	485	400
300	335	285	235	560	476	392	660	560	460

Table 2.10.3 Electric cable current ratings, normal operation, based on ambient 45°C

Nominal cross-section (mm^2)	Continuous r.m.s current rating, in amperes								
	Thermoplastic (70°C)			Elastomeric (90°C)			Elastomeric or thermosetting, based on silicon rubber (95°C)		
	Single core	2 core	3 or 4 core	Single core	2 core	3 or 4 core	Single core	2 core	3 or 4 core
0,75	10	8	7	15	13	11	17	14	12
1	12	10	8	18	15	13	20	17	14
1,25	13	11	9	21	18	14	23	20	16
1,5	15	13	11	23	20	16	26	22	18
2	18	15	12	28	24	19	31	26	22
2,5	21	18	15	40	26	21	32	27	22
3,5	26	22	18	37	32	26	39	33	28
4	29	25	20	51	34	28	43	37	30
5,5	35	30	24	49	42	35	52	44	37
6	37	31	26	52	44	36	55	47	39
8	44	37	31	62	53	44	66	56	46
10	51	43	36	72	61	50	76	65	53
14	62	53	44	88	75	62	94	80	66
16	68	58	48	96	82	67	102	87	71
22	83	70	58	117	100	82	124	106	87
25	90	77	63	127	108	89	135	115	95
30	101	85	70	142	121	100	151	128	106
35	111	94	78	157	133	110	166	141	116
38	117	99	82	165	140	116	175	149	122
50	138	117	97	196	167	137	208	177	146
60	155	132	109	220	187	154	233	198	163
70	171	145	120	242	206	169	256	218	179
80	186	158	130	263	224	184	278	237	195
95	207	176	145	293	249	205	310	264	217
100	213	181	149	302	257	212	320	272	224
120	239	203	167	339	288	237	359	305	251
125	245	209	172	348	295	243	368	313	258
150	275	234	193	389	331	272	412	350	288
185	313	266	219	444	377	311	470	400	329
200	329	280	230	466	396	326	494	420	346
240	369	314	258	522	444	365	553	470	387
300	424	360	297	601	511	421	636	541	445

Table 2.10.4 Electric cable current ratings, r.m.s. short circuit current

Nominal cross section	Fault current at 250°C duration			Fault current at 150°C duration			Fault current at 130°C duration		
	1,0 sec. kA	0,5 sec. kA	0,1 sec. kA	1,0 sec. kA	0,5 sec. kA	0,1 sec. kA	1,0 sec. kA	0,5 sec. kA	0,1 sec. kA
1	0,1	0,2	0,5	0,1	0,2	0,4	0,1	0,2	0,3
1,5	0,2	0,3	0,7	0,2	0,3	0,5	0,2	0,3	0,5
2,5	0,4	0,5	1,1	0,3	0,4	0,9	0,3	0,4	0,8
4	0,6	0,8	1,8	0,5	0,7	1,5	0,4	0,6	1,3
6	0,9	1,2	2,8	0,7	1,0	2,2	0,6	0,9	2,0
10	1,5	2,1	4,6	1,2	1,6	3,7	1,0	1,5	3,3
16	2,3	3,3	7,4	1,9	2,6	5,9	1,7	2,4	5,3
25	3,6	5,2	12	2,9	4,1	9,2	2,6	3,7	8,2
35	5,1	7,2	16	4,1	5,8	13	3,6	5,2	12
50	7,3	10	23	5,8	8,2	18	5,2	7,4	16
70	10	14	32	8,2	12	26	7,3	10	23
95	14	20	44	11	16	35	9,9	14	31
120	17	25	55	14	20	44	13	18	40
150	22	31	69	17	25	55	16	22	49
185	27	38	85	22	31	68	19	27	61
240	35	49	110	28	40	89	25	35	79
300	44	62	140	35	50	110	31	44	100

Table 2.10.4 Electric cable current ratings, r.m.s. short-circuit current

Nominal cross-section (mm^2)	Fault current (kA) at 150°C			Fault current (kA) at 250°C			Fault current (kA) at 350°C		
	1 s duration	0,5 s duration	0,1 s duration	1 s duration	0,5 s duration	0,1 s duration	1 s duration	0,5 s duration	0,1 s duration
0,75	0,1	0,1	0,3	0,1	0,2	0,3	0,1	0,2	0,4
1	0,1	0,2	0,3	0,1	0,2	0,5	0,2	0,2	0,5
1,25	0,1	0,2	0,4	0,2	0,3	0,6	0,2	0,3	0,7
1,5	0,2	0,2	0,5	0,2	0,3	0,7	0,3	0,4	0,8
2	0,2	0,3	0,7	0,3	0,4	0,9	0,3	0,5	1,1
2,5	0,3	0,4	0,9	0,4	0,5	1,1	0,4	0,6	1,4
3,5	0,4	0,5	1,2	0,5	0,7	1,6	0,6	0,8	1,9
4	0,4	0,6	1,4	0,6	0,8	1,8	0,7	1,0	2,2
5,5	0,6	0,8	1,9	0,8	1,1	2,5	0,9	1,3	3,0
6	0,7	0,9	2,1	0,9	1,2	2,7	1,0	1,5	3,2
8	0,9	1,2	2,8	1,1	1,6	3,6	1,4	1,9	4,3
10	1,1	1,5	3,5	1,4	2,0	4,5	1,7	2,4	5,4
14	1,5	2,2	4,8	2,0	2,8	6,3	2,4	3,4	7,6
16	1,7	2,5	5,5	2,3	3,2	7,2	2,7	3,9	8,7
22	2,4	3,4	7,6	3,1	4,5	10,0	3,8	5,3	11,9
25	2,7	3,9	8,6	3,6	5,1	11,3	4,3	6,0	13,5
30	3,3	4,6	10,4	4,3	6,1	13,6	5,1	7,3	16,2
35	3,8	5,4	12,1	5,0	7,1	15,8	6,0	8,5	18,9
38	4,1	5,9	13,1	5,4	7,7	17,2	6,5	9,2	20,6
50	5,5	7,7	17,3	7,2	10,1	22,6	8,6	12,1	27,1
60	6,5	9,3	20,7	8,6	12,1	27,1	10,3	14,5	32,5
70	7,6	10,8	24,2	10,0	14,2	31,7	12,0	16,9	37,9
80	8,7	12,3	37,6	11,4	16,2	36,2	13,7	19,4	43,3
95	10,4	14,7	32,8	13,6	19,2	43,0	16,3	23,0	51,4
100	10,9	15,4	34,5	14,3	20,2	45,2	17,1	24,2	54,1
120	13,1	18,5	41,4	17,2	24,3	54,3	20,5	29,0	64,9
125	13,6	19,3	43,1	17,9	25,3	56,6	21,4	30,2	67,6
150	16,4	23,2	51,8	21,5	30,4	67,9	25,7	36,3	81,2
185	20,2	28,6	63,9	26,5	37,4	83,7	31,7	44,8	100,1
200	21,8	30,9	69,0	28,6	40,5	90,5	34,2	48,4	108,2
240	6,2	37,0	82,8	34,3	48,6	108,6	41,1	58,1	129,9
300	32,7	46,3	103,6	42,9	60,7	135,7	51,3	72,6	162,3

Table 2.10.5 Correction factors

Insulation material	Correction factor for ambient air temperature of °C										
	35	40	45	50	55	60	65	70	75	80	85
PVC, Polyethylene	1,29	1,15	1,00	0,82	—	—	—	—	—	—	—
EPR, XLPE	1,12	1,06	1,00	0,94	0,87	0,79	0,71	0,61	0,50	—	—
Mineral, Silicon rubber	1,10	1,05	1,00	0,95	0,89	0,84	0,77	0,71	0,63	0.55	0,45

Table 2.10.5 Correction factors

Insulation material	Correction factor for ambient air temperature of °C										
	35	40	45	50	55	60	65	70	75	80	85
Thermoplastic (70°C)	1,18	1,10	1,00	0,89	0,77	0,63	—	—	—	—	—
Elastomeric or thermosetting (90°C)	1,10	1,05	1,00	0,94	0,88	0,82	0,74	0,67	0,58	0,47	—
Elastomeric or thermosetting, based on silicone rubber (90°C)	1,10	1,05	1,00	0,95	0,89	0,84	0,77	0,71	0,63	0.55	0,45

10.8 Installation of electric cables

10.8.10 Where single cables, or bundles of cables grouped in accordance with Table 1.10.8, run parallel with cables or bundles of cables of a different group for a distance greater than 1 m, a minimum separation distance of 0,1 m is to be ensured to reduce mutual interference.

Existing paragraphs 10.8.10 *to* 10.8.17 *have been renumbered* 10.8.11 *to* 10.8.18.

10.8.19 Electric cables are to be, so far as reasonably practicable, installed remote from sources of mechanical damage. Where necessary, the cables are to be protected in accordance with the requirements of 10.9.

10.8.20 Electric cables, with the exception of those for portable appliances and those installed in protective casings, are to be fixed securely in accordance with the requirements of 10.10.

10.8.21 Where electric cables penetrate bulkheads and decks, the requirements of 10.11 are to be complied with.

10.8.22 Where electric cables are installed in protective casings, the requirements of 10.12 are to be complied with.

10.9 Mechanical protection of cables

10.9.1 ~~Electric cables are to be, so far as reasonably practicable, installed remote from sources of mechanical damage.~~ Where electric cables are exposed to risk of mechanical damage they are to be protected by suitable protective casings unless the protective covering (e.g. armour or sheath) is sufficient to withstand the possible cause of damage.

10.16 Joints and branch circuits in cable systems

10.16.3 Cables of a fire-resistant type, *see* 10.5.3, are to be installed so that they are continuous throughout their length, without any joints or tappings.

Section 11
Batteries

11.5 Ventilation

11.5.1 Battery compartments and boxes are to be ventilated to avoid accumulation of dangerous concentrations of flammable gas. The ventilation openings are to be of a non-closeable type, with the exception of closing devices in accordance with 11.5.2, and a permanent notice is to be prominently displayed adjacent to them, stating:

> THIS VENTILATOR OPENING IS NOT TO BE CLOSED OR BLOCKED AT ANY TIME – EXPLOSIVE GAS.

11.5.2 Closing devices in battery compartment ventilation openings are to be provided with a means to be locked open. A permanent notice is to be prominently displayed adjacent to each one to make clear that the closing device is to be closed only in the event of a fire.

Existing paragraphs 11.5.2 *to* 11.5.10 *have been renumbered* 11.5.3 *to* 11.5.11.

16.6 Fire safety stops

16.6.8 Means of cutting off all electrical power to the galley except lighting circuits, in the event of a fire, is to be provided outside the galley exits, at positions which will not readily be rendered inaccessible by such a fire.

Section 18

Craft safety systems

18.1 Watertight doors

18.1.2 ~~For passenger craft, where the sources for opening and closing the watertight doors have electric motors, unless an independent temporary source of stored energy is provided, the electric motors are to be capable of being automatically supplied from the transitional source of emergency electrical power.~~

Existing paragraphs 18.1.3 *to* 18.1.12 *have been renumbered* 18.1.2 *to* 18.1.11.

Section 20

Testing and trials

20.2 Trials

20.2.4 It is to be demonstrated that the Rules have been complied with in respect of:

(a) satisfactory performance of each generator throughout a run at full rated load;

(b) temperature of joint, connections, circuit-breakers and fuses;

(c) the operation of engine governors, synchronising devices, overspeed trips, reverse-current, reverse-power and over-current trips and other safety devices;

(d) voltage regulation of every generator when full rated load is suddenly thrown off and when starting the largest motor connected to the system;

(e) voltage drop;

(f) harmonic distortion of the voltage waveform;

~~(e)~~(g) satisfactory parallel operation, and kW and KVA load sharing of all generators capable of being operated in parallel at all loads up to normal working load;

~~(f)~~(h) alarm sound pressure levels; and

~~(g)~~(j) all essential and other important equipment are to be operated under service conditions, though not necessarily at full load or simultaneously, for a sufficient length of time to demonstrate that they are satisfactory.

20.2.5 Voltage drop is to be measured, where necessary, to verify that this is not in excess of that specified in 1.7 or 19.9. Where necessary, measurements are to be taken as part of the trials specified in 20.2.4 (c), (d), (e) and (f), to verify that the installation will provide a quality of power supply in accordance with the values listed in 1.7.

Section numbering in brackets reflects any Section renumbering necessitated by any of the Notices that update the current version of the Rules for Special Service Craft.

Part 10, Chapter 1

13.5.1	*Reference* 2.12.2 *now reads* 2.13.2

Part 14, Chapter 1

7.2.6	*Reference* 7.1.2 *has now been deleted*

Part 16, Chapter 1

1.2.5.h	*Reference* 2.12.6 *now reads* 2.13.6
2.5.11	*Reference* 2.12.2 *now reads* 2.13.2
2.10.1	*Reference* 2.12 *now reads* 2.13
2.10.1	*Reference* 2.13 *now reads* 2.14
2.10.2	*Reference* 2.13 *now reads* 2.14
2.10.5	*Reference* 2.12.7 *now reads* 2.13.7
2.10.6	*Reference* 2.12.2 *now reads* 2.13.2
2.10.6	*Reference* 2.12.9 *now reads* 2.13.9
2.10.9	*Reference* 2.12.6 *now reads* 2.13.6
2.12.1	*Reference* 2.12.2 *to* 2.12.10 *now reads* 2.13.2 *to* 2.13.10
2.13.1	*Reference* 2.13.2 *to* 2.13.7 *now reads* 2.14.2 *to* 2.14.7

Part 16, Chapter 2

5.3.6	*Reference* 5.3.5 *now reads* 5.3.6
10.13.1	*Reference* 10.8.14b *now reads* 10.8.15b

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